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ABSTRACT

This study explores a wide variety of technical alternatives, from equipment needs and on-the-ground system design, to equipment operation and suggested applications for department activities, both now and in the future. Some suggested alternatives include (1) communication satellites, (2) one way audio transmission, (3) one and two way hard copy transfer, (4) two way audio delivery network, (5) data transfer, and (6) video. Each alternative is discussed and diagrammed to serve as a primer for the Alaskan educator unfamiliar with the technology of telecommunications. Appendices present a summary of systems requirements, a summary of implementation possibilities, a simplified glossary of common telecommunication terms, and a summary of system requirements in the areas of required satellite capacity, program source, equipment, operator training, support staff, systems stability, equipment placement, and flexibility of use. A bibliography is included. (JEG)

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EDUCATIONAL TELECOMMUNICATIONS ALTERNATIVES FOR ALASKA

Product 1

January 30, 1976

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Prepared for:

Alaska Department of Education
Marshall L. Lind, Commissioner

Ernest Polley
Marsha Freer
Co-Chairpersons of the Telecommunications
Task Force, Department of Education

IR006132

EDUCATIONAL TELECOMMUNICATIONS ALTERNATIVES FOR ALASKA

Product 1

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Preface

This document was designed for two reasons. First, the document is to serve as a primer for the Alaskan educator unfamiliar with the technology of telecommunications. Secondly, it is hoped that the document will serve as a stimulus for generating ideas for the productive application of telecommunications to educational needs. Several possible uses are outlined in the main content of the document.

Should you desire, there is a video-tape available for loan which parallels this document. Please contact the following address for delivery of the tape.

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EDUCATIONAL TELECOMMUNICATIONS ALTERNATIVES FOR ALASKA

A satellite-based educational delivery system could provide essential services to the Alaska Department of Education in meeting a wide variety of educational needs in Alaska. The communications possibilities could have direct application to the General Operational Goals listed by the Department (in its publication "What's It All About?", an overview of Department activities):

1. To facilitate desirable educational change.

2. To provide support services in the areas of school and library management, finance, and educational program design.

3. To provide evaluation and monitoring functions to promote systems quality.

4. To exercise all assigned legal responsibilities for the purpose of encouraging quality education for all Alaskans.

This study will explore a wide variety of technical alternatives, from equipment needs and on-the-ground system design, to equipment operation and suggested applications for Department activities, both now and in the future.

Nowhere in the world has an exploration of the full range of telecommunications services for education been done before. Alaska, and the Department of Education, are in the unique position of setting international precedents for a statewide network fully utilizing all aspects of telecommunications.

Communications Satellites

To understand what can be done with satellite communications, we must first understand how a satellite works. The technology is complex, but the principles behind it are simple.

Communications satellites act as repeaters in the sky, receiving signals and sending them back to earth. Signals are received from and sent to the satellite by Earth Stations, with specially equipped antennas.

These satellites orbit 22,300 miles above the earth, over the equator. In this orbit path, a satellite revolves around the earth at the same speed as the earth rotates on its axis; one orbit takes 24 hours. This is called synchronous equatorial orbit, and it plays a vital part in making satellite-receiving networks possible today.

Synchronous orbit keeps a satellite in direct line of sight with a fixed area on the earth. It eliminates the need for large, expensive earth stations to track a satellite in its orbit. A satellite in synchronous orbit can communicate with whole networks of small earth stations that cost thousands, not millions, of dollars.

It is this advanced technology that makes satellite communication possible for the widely scattered rural areas of Alaska. A network of 100 or more small earth stations will be installed and fully operational in rural communities of the State by the end of 1977.

Satellite communications will only be possible immediately in villages where earth stations are installed. Stations will initially be placed in villages with no existing communications. Twenty earth stations will be completed by March 1976, with approximately 45 planned for installation during 1976, and the remainder in 1977.

But this need not limit DOE'S establishing a total satellite communication network in additional locations, if it desires to do so in the future. It is possible that a village could be linked by ground lines to an earth station in a nearby village. It is also possible that State agencies, working together, could show a substantial need for expanding the system beyond the initial 100 earth stations.

A brief description of the technical capacity of a communications satellite is important here, because this directly affects the kinds of things a satellite can do.

Each satellite has several communications repeaters that receive signals, amplify them, and broadcast them to earth on a different frequency. These repeaters are called transponders. Each transponder can handle a variety of channels. (See Fig. 1)

For example, a transponder could carry hundreds of two-way telephone channels, or one channel for television, or a combination of channels for telephone calls, radio broadcasts or still pictures, as well as data transmission.

The amount of information which can be handled by a satellite depends on the number of transponders on board, the frequency range (bandwidth) of those transponders, and the satellite's power and antenna systems.

The bandwidth of each transponder affects the number of channels that are available for carrying information. The capacity of each channel is usually expressed in bandwidth, or bits per second. The higher the bandwidth, or bit rate, the greater the channel capacity. The charges for a channel are proportional to the amount of information it is required to carry.

Different types of information have different channel capacity requirements, depending on the highest frequencies contained in the original material. Figure 1 shows the frequencies and proportional channel requirements for different types of information.

Telephone quality voice, for instance, contains frequencies up to 4,000 cycles per second. A standard

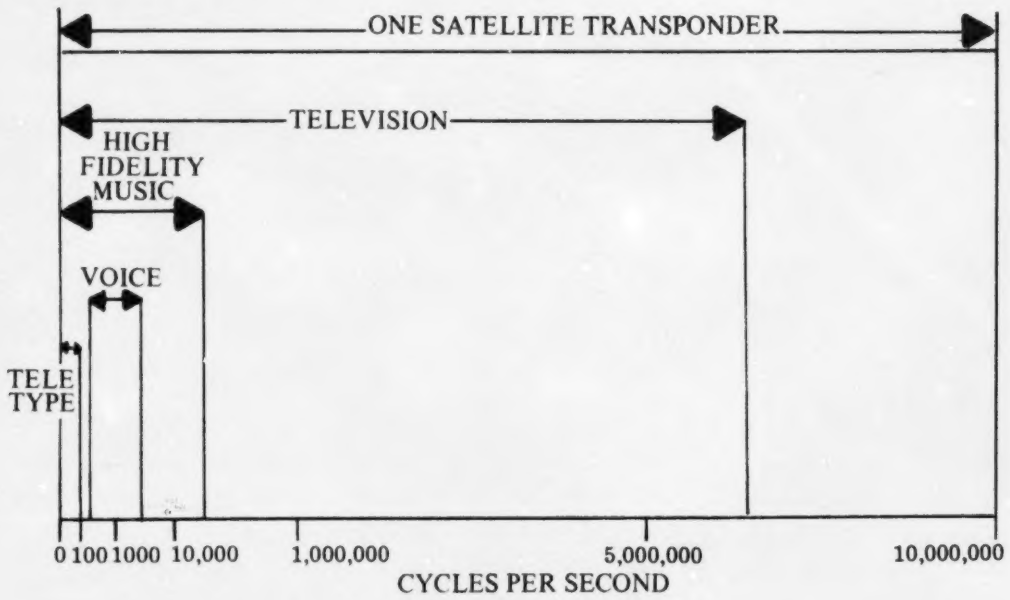

FIGURE 1
PROPORTIONAL CHANNEL FREQUENCY REQUIREMENTS

television signal contains frequencies up to 4.5 million cycles per second. A channel capable of carrying a television signal has the capacity to carry hundreds of voice channels.

On the other hand, 60 or 100 word-per-minute teletype signals require even less bandwidth than voice, and with the proper combining and separating equipment several different teletype messages can be transmitted simultaneously over a single voice channel.

Combining several signals for transmission over a single channel is known as multiplexing.

Now, what do these technical capacities offer? What kinds of things can a satellite do for you?

To set some direction to our explanations, we will be discussing five basic communications categories, or mediums:

I. AUDIO

A. HARD COPY TRANSFER
One-way /
B. DATA TRANSFER

II. VIDEO

III. VIDEO/AUDIO

I. AUDIO

An audio communications channel generally carries material or frequencies that can be detected by the human ear, and usually this means either voice or music.

Channels with sufficient bandwidth for audio can also be used to transmit hard (printed) copies of information as well as direct data transfer.

Audio channels vary in quality, and one which just meets the minimum requirements for telephone use would not be suitable for high-fidelity music. Thus, in discussing a system design, the quality (and cost) of the channels chosen depend on the kind of information to be transmitted.

One-Way Audio Transmission

The simplest use of an audio channel is for one-way-transmission. Common examples of one-way audio delivery are public address systems or commercial radio broadcasts.

One-way audio can be used for any material or information that does not require immediate listener response. The advantage of one-way audio is its speed: Information now distributed by mail could be transmitted immediately.

The equipment for one-way audio delivery could be as simple as a microphone and amplifier at a DOE central location, connected by cable to a transmitting earth station; and an amplifier and speaker at all receiving points, connected by a cable to a receiving earth station. (See Figure 2)

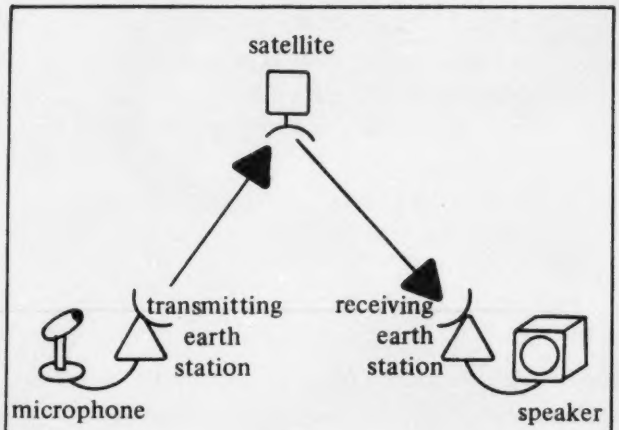

FIGURE 2
ONE-WAY AUDIO DELIVERY SYSTEM

The cost of this simple equipment could be as low as $200 at either end. Once the equipment had been connected by cable to the earth station, it would merely need to be plugged in to a standard 110 v electrical outlet.

There is virtually no special training required to operate this simple one-way audio system. Transmission would originate at a microphone with an on-off switch. If the speaker is always kept on, reception of any transmission would be immediate at all points. Control of this system rests with the one central transmitting point.

An expanded one-way audio delivery system depends on the content of the information or programming it needs to carry.

There are a number of options for delivery systems at the receive locations.

1. One speaker could be placed in each school, in the administrator's office. This arrangement could provide:

- immediate notification of changes in DOE regulations or reporting procedures.
- notification of special meetings.
- summaries of conference or workshop results.
- summaries of new materials available at resource centers.
- notices of new programs available through DOE (scholarships, grants, etc.).

The advantages of a regularly scheduled, verbal report to all administrators would be the ease of access, reduction in paperwork and mailing costs, and immediate notification of current events.

The disadvantages are that there is no way to monitor whether the system is being regularly used; no permanent record or report can be provided; and users cannot ask questions for clarification.

2. Another arrangement might be to place a speaker in the school's office, and in each classroom. This would allow use of the system for administrative information (as above) and for student/teacher support, such as:

Student Support

- instructional programs, either prepared programs available from a wide variety of national educational program distributors, or programs originated by DOE.

Teacher Support

- prepared teacher training programs.
- discussions of new techniques in various fields.
- reports on teacher training seminars in the state.
- reviews of books, or available resources for classroom use.
- dissemination of information to educators on professional practices.

The programming possibilities, especially for student/teacher support, include the option of developing a fully equipped sound studio to originate audio programs. This would allow for programming beyond simple spoken reports or lecture-type instruction.

A few of the options for originally produced programming could be:

- discussion forums with educators.
- in-depth interviews.
- dramatizations.
- documentaries.
- productions using music, pre-taped material, and discussion.
- special events and news coverage.

A studio with the equipment to provide all of these audio options could be established for as little as $10,000. By pre-taping programs, a single production facility could provide program orientation for multi-channel operation (more on that to come).

One-way audio program transmission need not be limited strictly to broadcasts during school hours, but could be recorded in the evenings, for example. A tape recorder could be modified to turn on when a particular audio tone is sent over the system, and programs would be automatically recorded for later use by teachers or administrators. This equipment, with proper modifications, could cost as little as $200 per site.

3. A number of other variations of one-way audio delivery system design could provide transmissions directly to people's homes, for dissemination of public information.

With the cooperation of the local radio station, programs via satellite could be received directly at the station, for use on the air. The only real cost involved would be for installation of a cable connecting the earth station and the radio station.

In towns with an existing cable TV system, audio programs via satellite could be broadcast directly to FM radio receivers in each home, for a cost of around $1,000 per site.

Another technical possibility for public education would be a mini-FM (10 watt) radio transmitter that could be located in a village and connected to the earth station. The broadcast range of such a station could be limited to the village, where it was located and nearby areas, depending on the power of the station, antenna height, and the local terrain.

Establishing such stations could conceivable be coordinated through the Alaska Educational Broadcasting Commission (AEBC) within the Department, and would also require licensing by the Federal Communications Commission (FCC).

A mini-transmitter could broadcast educational programs from a one-way voice channel through the satellite directly to the public. It would also be possible to develop local broadcasts, with the added advantage of providing a practical education in broadcasting to both students and townspeople. The cost of a mini-FM transmitter would be in the vicinity of $5,000.

These possible distribution designs could provide public information about:

- –new programs available within the Department.
- –new regulations affecting old programs.
- –public service messages.
- –adult educational programming.

In any of its possible delivery forms, one-way audio programming could be coordinated by pre-determined schedules of broadcasts, distributed in written form well in advance; or schedules could be distributed over the system verbally each week, or each day.

So far, we've discussed the delivery options at one specific location. Again, depending on the program and information content of what is transmitted, there are a number of options for program delivery to the earth station network.

1. A single program could be delivered to all receiving sites through a simple distribution system using only 1 one-way audio channel (See Figure 3).

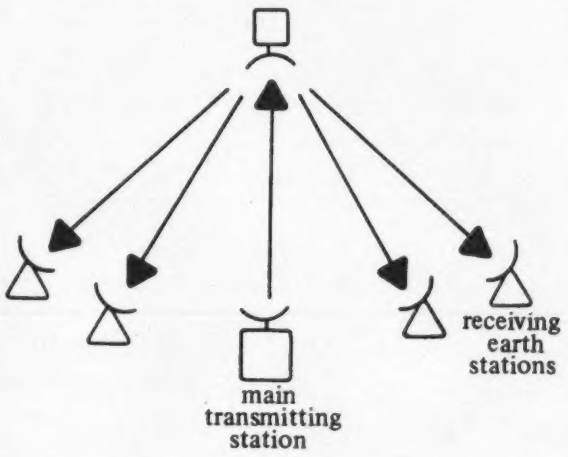

FIGURE 3
STATEWIDE DELIVERY
OF SINGLE AUDIO PROGRAM

2. Or more than one program could be transmitted at the same time, with regionally assigned reception. The central control could determine, by channel selection, which region receives each of the different programs (See Figure 4).

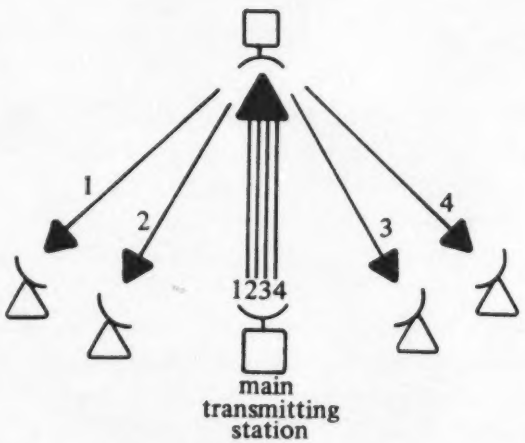

FIGURE 4
REGIONALLY ASSIGNED DELIVERY
OF MULTIPLE PROGRAMS

This system would require an additional one-way audio channel for each simultaneous broadcast: three programs broadcast at the same time would require three separate audio channels.

3. Or more than one program could be transmitted at the same time, with each location having the option to make its own choice about which one to listen to (See Figure 5). This would give total local control to the system. Speakers at each location could be designed with a channel selecting knob; each location would select the channel it wanted to receive.

This system would also require a one-way channel for each program that was broadcast simultaneously.

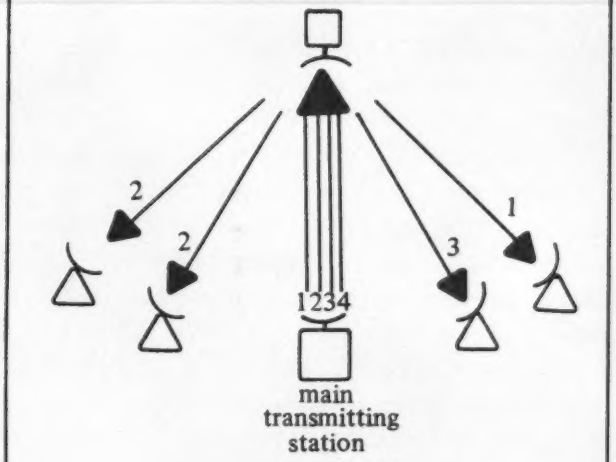

FIGURE 5
LOCAL SELECTION
OF MULTIPLE PROGRAM DELIVERY

With any of the options for one-way audio system design, there is another variable of how many hours a day the system would operate.

The options for leasing satellite time might be:

1. Use of one voice channel through the satellite, on a ten-hour a day basis. This would provide program distribution during school hours,

allowing time zone differences. Programs could still be recorded for later use, but only during school hours.

2. Use of one voice channel through the satellite on a 24-hour a day basis. This is a dedicated channel, which in effect means leasing exclusive, 24-hour access to a channel, usually at a standard monthly rate. Programs transmitted outside of school hours could be recorded for later use.

3. Use of a number of audio channels (either 10 or 24-hours per day) to allow a variety of different simultaneous broadcasts.

Costs for satellite use are generally determined on the amount of time a transponder is in use. As use increases, the cost-per-hour becomes proportionally less.

Irregular use of a satellite (say, less than an hour a day) would be cheapest, paid on an hourly use basis. This is practical if use does not exceed several hours a day. But there is a break point, where hourly use becomes economically impractical. Ten-hour per day use might not cost significantly less than 24-hour a day use.

A rough estimate of cost figures for 24-hour a day use of good quality one-way audio to 100 earth stations is less than $3,750 per year, or $38 per site per year. This is based on the assumption that transponder use per year will be approximately $1,000,0C All tariff rates for satellite use have yet to be determined by the Alaska Public Utilities Commission (APUC), and they could be considerably less than the figures used here.

I. A. ONE-WAY HARD COPY TRANSFER

One-way audio channels can also be used for transmitting data and information, rather than audio programs. Information is transmitted through an audio channel in coded form, usually pulses (bits) or groups of pulses.

Teletype

Teletype is one of the simplest means of transmitting written messages. Teletype communications can be carried out using voice grade channels. A one-way teletype system could be installed at earth station sites as they become operational; the equipment is now readily available.

This system should require standard teletype machines, similar to those used now in most newsrooms. The machine has a keyboard much like a typewriter. Messages are typed on the keyboard and printed on paper, transmitted to the receiving site, and printed out there. A typist could learn to operate a teletype in a matter of days. With a one-way teletype system, a trained operator would be required only at the central transmitting location. No special training would be required to operate the equipment at the receiving end; the teletype would simply print out the message.

A standard teletype machine, with installation, costs under $1,500.

Receiving teletype machines could be installed in earth station site schools in the administrator's office, for example. Messages could be transmitted from one central teletype at DOE headquarters. By using a code (See Figure 6), messages could be sent directly to:

1. Only one location.

2. All locations in one region.

3. Or all locations in the state.

The advantage of teletype is that it produces a printed, or hard, copy at both the sending and receiving ends. For administrative purposes, this might be more effective than simple voice communication, because it provides a permanent record.

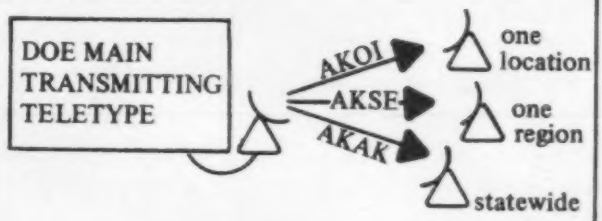

FIGURE 6

ONE-WAY TELETYPE MESSAGE DELIVERY

Teletype would seem to apply most directly to management needs, to distribute messages originating with DOE that require no immediate response, and for messages it would be helpful to have in printed form, such as:

- –notices of DOE activities or regulation changes.
- –meeting announcements.
- –summaries of conferences or workshops.
- –reminders of reports due.

The cost of leasing a 24-hour satellite channel for one-way teletype messages will probably be less than the cost of a regular audio channel.

There are several possibilities for establishing a teletype network through the earth stations:

1. Teletype alone could be transmitted on a 24-hour basis, used as needed. (The cost would be about $3,750 per year/100 sites.)

2. A 24-hour teletype channel could be used in addition to a 10-hour or 24-hour a day audio channel. (The cost would be somewhere between $3,750 and $7,500 per year for both channels to 100 sites.)

3. One audio channel could be leased on a 24-hour basis, and used for audio programming during school hours, with teletype messages and audio programs transmitted and recorded at night. (This would allow the use of both audio and teletype one-way transmissions for the approximate cost of $3,750 per year/100 sites for one full audio channel.)

The one-way audio systems described are technically possible today, and equipment is available. One-way communication can definitely serve a purpose for information that needs to be distributed quickly and that doesn't require immediate user reaction. One advantage is that training required for field operators of receive–only equipment is minimal.

It should be carefully noted, however, that one-way communication has some practical limitations:

- –The system doesn't allow for response, comments, questions, or feedback from users.
- –It is essentially controlled by the central transmitting location. The option at the local level is merely whether to turn the equipment on or not.
- –There is no direct way to monitor use of the system. Utilization at each location would be voluntary

Note: All cost figures included here are estimates only. Equipment prices may vary, depending on exact specifications. Tariff rates to be charged for satellite use will be established under the regulating authority of the APUC.

Cost estimates also do not include maintenance variables. Leasing equipment can offer the advantage of supplier maintenance. Given the difficulties of travel and transportation in Alaska, another option is to plan purchase of extra equipment during the installation phase of a network. This will increase the cost, but will allow for back-up equipment that can be put in use on short notice when there is a break down.

Two-Way Audio Transmission

Two-way audio is more complex because it requires sending and receiving equipment at all locations. Virtually everything that can be done one-way can also be done with two-way audio, with additional equipment and, in some cases, additional satellite channels. This increases both the cost and the need for training equipment operators in the field.

There are two basic types of two-way audio systems. The simplest is called simplex and uses only one audio channel through the satellite. Since this allows only one signal in one direction to be broadcast at a time, it is similar to a push-to-talk type of radio. One party talks while the other party listens, then the second party talks and the first party listens. They cannot talk simultaneously and understand each other.

The duplex two-way audio system uses a pair of audio channels. One channel transmits while the other channel receives.

A two-way audio system could be as simple as a microphone and speaker, with amplifiers, at each earth station location. The possibilities for placing this equipment at each school are similar to those described for a one-way audio system. It would be possible to place a speaker and microphone, with easily operated on-off switches, in every classroom and administrative office. This could provide direct communication between the Department and every rural educator.

The possible uses for two-way audio include:

Management

DOE Originated
- –notification of changes in DOE regulations of reporting procedures
- –organization of special meetings on short notice
- –broadcasts of conference or workshop results for those who could not attend
- –requests for information from District
- –requests for evaluation of audio programming, scheduling, etc.
- –reminders of reports due

District Originated
- –requests for clarification of regulation or procedural changes
- –inform DOE of who will attend from District/ travel arrangements
- –supply information requested by DOE
- –immediate feedback on quality use, ease of use of audio programs
- –requests to resource centers or Library for information
- –requests to DOE for assistance

Student Support

DOE Originated
- –instructional audio programs
- –bi-lingual instruction

Student Originated
- –interaction during instruction
- –discussions and interaction with other students

Teacher Support

DOE Originated
- –teacher training programs
- –training seminars with many rural teachers
- –requests for evaluation of programs
- –provide update of resource material available
- –dissemination of information on professional practices

Teacher Originated
- –interaction during instruction
- –interaction with other teachers
- –direct feedback on programs
- –requests for resource material

Essentially, two way audio could be beneficial to increase regularly-scheduled access and communication between rural educators and DOE. It could help eliminate some of the paperwork of special or one-time information requests by DOE, and could handle effectively some of what is now done face- to-face, such as teacher conferences.

It might also be possible to utilize two-way audio to coordinate audio programming planning input from rural educators. This could be done by statewide audio conferences with rural planners to make progress evaluation feedback available to all, provide updates on requested program changes or progress on new programs, and to coordinate face-to-face meetings for planning.

The following options for two-way audio channel use and network design are applicable to either simplex or duplex systems.

1. In the simplest two-way system network all locations share the same channel. Each station can hear the transmission of every other station (See Figure 7). A common channel shared by all sites has the advantage of allowing all to participate in discussions and multipoint conferencing. But it has the disadvantage of lacking privacy.

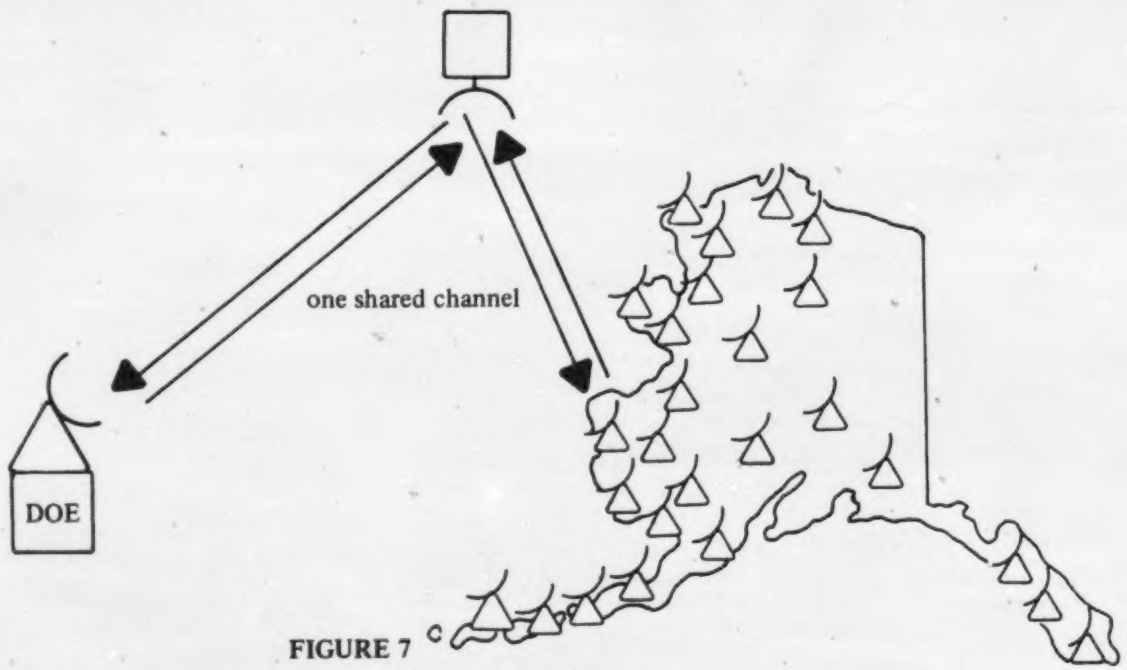

FIGURE 7

TWO-WAY AUDIO DELIVERY NETWORK

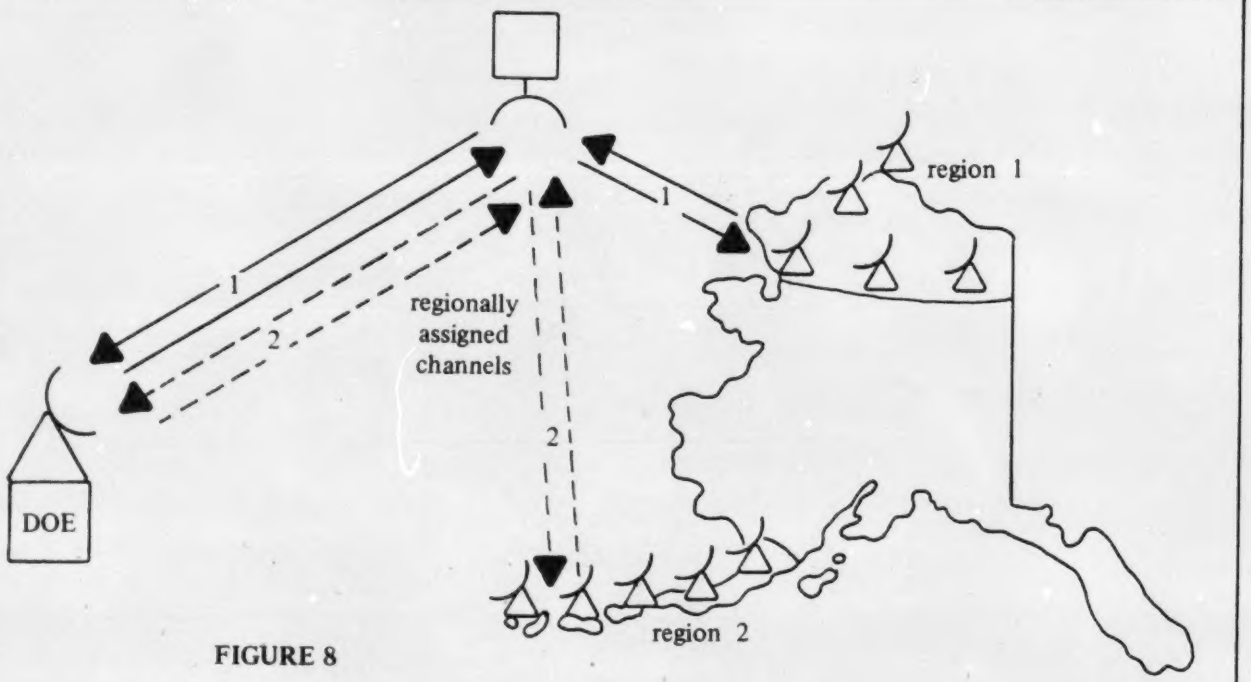

FIGURE 8

TWO-WAY AUDIO DELIVERY NETWORK

2. A greater degree of privacy could be achieved by assigning channels for use on a regional basis (See Figure 8). For example, the State might be divided into six regions for this communication network. Schools in Region 1 could talk with all other schools in Region 1, and with DOE; schools in Region 2 could talk with all other schools in Region 2, and with DOE, etc.

This would not eliminate the possibility for having statewide conferencing.

If desired, a channel selector could be located at every school in the State. Region 1, using channel 1 normally, could push a button and select to talk on channel 2, to communicate with Region 2 (Figure 8–A). A statewide discussion could be held if all Regions selected the same channel.

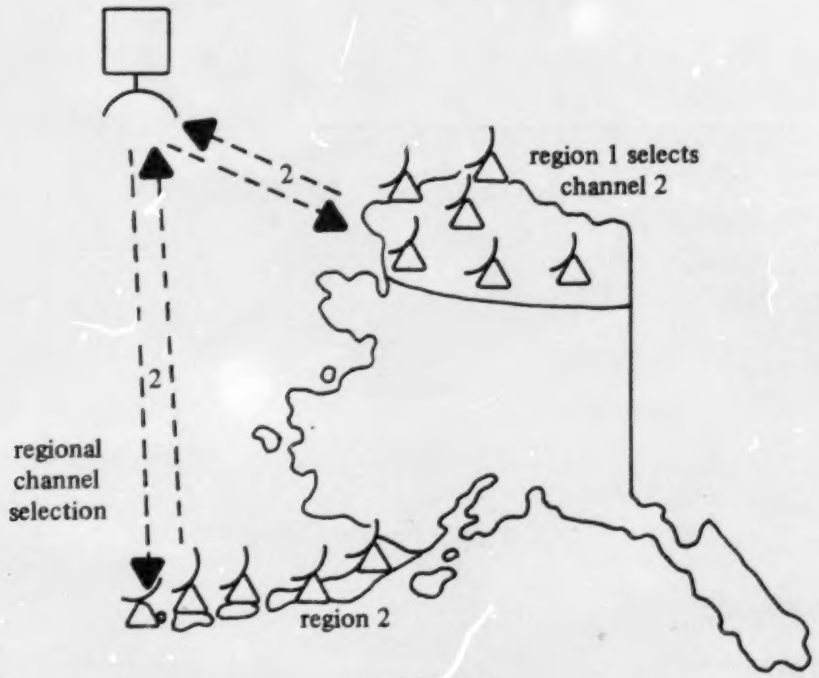

FIGURE 8-A

TWO-WAY AUDIO DELIVERY NETWORK

3. The most expensive alternative is to provide a separate, dedicated channel to each earth station location (Figure 9). Even disregarding the high cost of this alternative, its advantages of privacy, positive control and immediate access may be outweighed by the disadvantages of no conferencing and no direct communications with all others on the network.

Privacy and network control can be accomplished, if desired, on a shared channel network with ancillary equipment such as scramblers, remote central control for coordinating outlying station transmission, and automatic station identifiers. The cost of this equipment would, in the long run, probably be cheaper than leasing many dedicated channels.

The delivery costs for extended two-way audio systems increase as the number of transmitting channels increases. Equipment costs at both ends will also go up as channel access is increased (but not necessarily in direct proportion to the channel increase). Cost estimates can realistically be made only for a system design with specified operating needs.

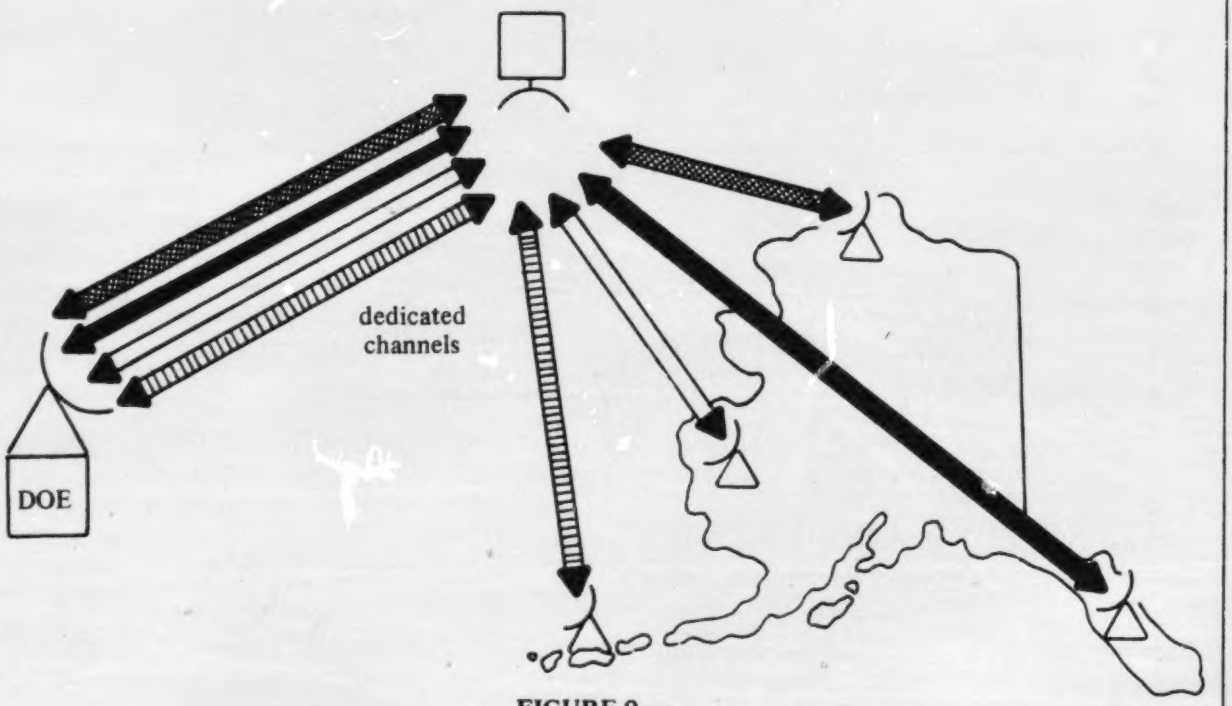

FIGURE 9

TWO-WAY AUDIO DELIVERY NETWORK

I. A. TWO-WAY HARD COPY TRANSFER

Teletype

Two-way teletype capacity could operate on either simplex or duplex channels. Operation would be similar to that described for one-way transmission. Standard teletype machines could be located in each school (approximately $500 each). With minimal training, a typist at each location could be used to send messages from any transmitting location to (Figure 10):

1. Any other single location.
2. All other locations within one region.
3. Or all locations in the State.

On a simplex channel, only one message could be transmitted at a time. On a duplex channel, simultaneous messages could be transmitted. For example, if DOE headquarters sent a teletype message to Bethel, the message would be received and printed out on the machine at Bethel. At the same time, the Bethel operator could be sending a message back to DOE headquarters.

The cost of a duplex two-way teletype system would be approximately double the simplex system cost, because an additional portion of an audio channel is required for duplex. The simultaneous use possible with a duplex system would allow maximum use of the teletype network if traffic in both directions between two points were consistently heavy.

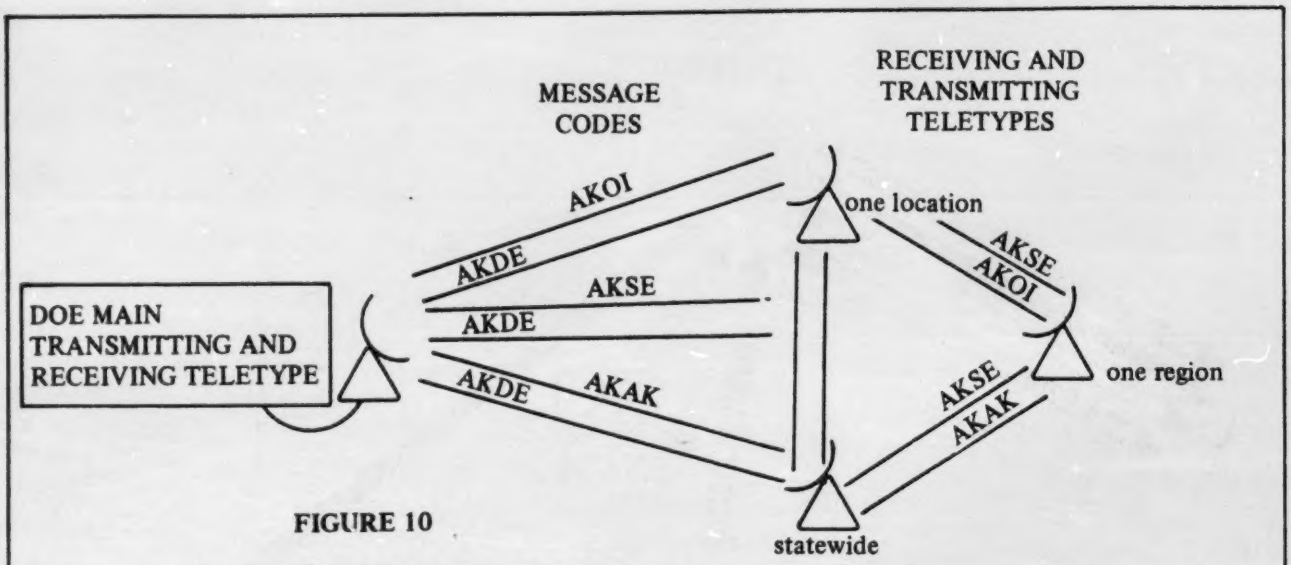

FIGURE 10

TWO-WAY TELETYPE MESSAGE DELIVERY

Two-way teletype could offer the following possibilities:

DOE Originated
–notices of DOE activities or regulation changes.
–meeting announcements.
–summaries of conferences or workshops.
–reminders of reports due.

District Originated
–requests for clarification of regulation changes.
–confirmation of attendance/travel arrangements.
–requests for further information or reports.
–requests for assistance.
–requests to other Districts.

Facsimile

A two-way audio channel could also be used for transmitting facsimile copies of information. This would operate very much like the standard telecopier machines now used in many offices.

The advantage of telecopier over teletype is that it provides exact written copies, rather than a teletype print out.

This would be especially useful in transmitting information when the mails would be too slow. For example:

DOE Originated
–contracts to be reviewed
–report forms
–long-hand written notes or info
–resource material requested by Districts

District Originated
–revised contracts
–completed report forms
–District-initiated reports or evaluations

Use of telecopiers would not directly require special satellite audio channels. The telecopier in each location could be connected directly to the long distance telephone, which operates through the satellite. The cost of the operation would be simply the cost of a long distance telephone call.

The equipment is easy to operate. Sites could be notified by a long distance telephone call that information was about to be sent by telecopier. Once notified, the receiving site would need merely to place the receiver of the telephone in the telecopier, put in a piece of blank paper, and transmission could begin.

Telecopiers now available can transmit one regular printed page in 4 to 6 minutes. The cost to purchase one machine is approximately $1300. Telecopiers could also be leased for about $50 a month per machine. Special chemically treated paper is needed to send and receive copies.

Faster telecopiers are currently being developed that will be able to transmit information at a higher rate per minute. (These are expected to be available before the end of 1976.) These machines will operate with laser-type beams and will not require specially treated paper. They will cost somewhat more than machines available today.

I. B. DATA TRANSFER

Data transfer involves the relay of coded information directly to computers, printers, or storage or decoding devices. Data systems for computer access require two-way audio channels to be effective.

A computer terminal with a keyboard for entering data could be located in each District's administrative office. The terminals could also have print-out capacity, similar to a teletype, or print-out on a video screen (cathode ray tube). Coded information would be typed into a keyboard and transmitted to one main computer working with all terminals. A trained operator would be required at each transmitting location.

Some possible management uses for this type of data transfer might be:

1. Student record keeping. Each school could record the name, age, sex, race and residence of every student enrolled. It might also be possible to record grade records for all students. This information could then be recalled by the main computer as needed for special reports or federal or state surveys.

2. Payroll and accounting procedures. Each rural terminal could supply information on hours of work, rate of pay, number of dependents, etc. for every employee, to allow computerized payroll processing.

3. Talent Bank of personnel sources in the State. Locally recommended experts could be located quickly, with requests entered on local keyboards for prompt response. All applications received by DOE could be on record for quick placement from still active lists.

4. Teacher certification. Up to date records of the status of all certified teachers could be kept centrally.

Cost estimates for computer systems vary greatly depending on the type of system desired. There are many variables to terminal, computer and satellite costs that depend on the specifics of each system design. In addition, personnel time would be required to design programs for computer use, and field operators would need to be trained.

There are a variety of student/teacher support services that computer based instruction could provide:

1. Computer-Assisted Instruction (CAI)

CAI is an individualized means of instruction that uses a computer as the medium for delivering lessons.

Students would interact with a computer

through a classroom computer terminal similar to a typewriter keyboard with a TV type display screen called a Cathode Ray Tube (CRT) or hard copy printer. The operating instructions for operating with the computer are quite simple. Students can learn to operate a terminal from a simple instruction manual, a teacher, or by the computer itself in the course of a lesson. As the student becomes more familiar with operation, lesson instructions can become more sophisticated.

A simple CAI program would involve a series of steps. The student presses the appropriate keys to begin interacting with the computer. A question appears on the CRT and the student is given four or five multiple choice answers to select from. He/she presses the appropriate key in response and receives immediate feedback on his/her answer. If it is incorrect, or if he/she has two or three incorrect answers in a row, the computer may prescribe a remedial program to have the student repeat the material before he/she can proceed. If she/he has too much difficulty, the computer may tell her/him to see the instructor before he/she can move ahead.

A more sophisticated type of CAI involves simulation. The computer can be programmed to allow the student to conduct experiments and participate in re-created events, or models. Simulations could include driver training courses, or role playing as government officials faced with important decisions, etc. This allows experiences that might otherwise be impossible for a student because of cost, safety factors or the unpredictability of a desired event occurring at a given time.

CAI allows students to proceed at their own rate, freeing a teacher's time. Lessons can be repeated as necessary. CAI might also prove to be less inhibiting than a standard classroom situation; a student might be less self-conscious about making a mistake only he/she and the computer can see.

System designs for CAI could include:

–A computer terminal with display screen located in each school, or in each classroom. This could provide tutorial instruction to individual students.

–Individual simplified keyboard terminals for every student in a classroom. This would allow students to operate their own terminal as needed, and could provide fully interactive instructions to each student. These terminals could interact with one main terminal or mini-computers, that can have access to state and national systems.

Software instructional packages for CAI are being developed nationally by a variety of agencies, and are becoming more available. CAI instruction packages also allow modification by teachers to add relevance to each student or class. A CAI package is also available to instruct teachers in preparing their own CAI instruction packages. Participating rural teachers could have access to all programs designed by other teachers specifically for Alaskan students.

The cost of CAI is directly related to the number of users. Experiments by CAI indicate that the cost can range from 30 cents to 60 cents per user per hour.

2. Computer-Managed Instruction (CMI)

CMI involves the use of a computer to manage a student's progress in a particular field of study. Using a keyboard terminal and print-out screen, the student is tested on her/his level of comprehension. Based on the student's level, the computer directs the student's progress by suggesting films, videotapes, books or other material to be studied. The student is then tested on comprehension of this material, and if successful, moves on to the next computer-suggested material.

CMI does not limit instruction to CAI's totally computer-oriented programming, but suggests other

source material for the student. Interaction with the classroom teacher, and the use of keyed textbooks can also be vital elements of CMI.

At the completion of each step, the student can be tested by the computer, and results reported to the teacher. In essence, the computer assists the teacher in providing a variety of material to the student and monitoring progress. This might be especially useful in Alaska if a teacher did not have expertise in a particular field, or did not have time to devote to specialized or remedial instruction.

CMI could use only 1 terminal per classroom quite effectively, because less computer time is required than for CAI.

3. Supplying Resource Materials

A future application of computer based systems might be to supply resource materials to rural schools. Through individual terminals, student or teacher could request films, videotapes, photographs, articles, or other information directly from a main computer located at a regional or statewide resource center. Upon receiving a request, the main computer could locate the material and arrange for its dissemination either through the mails (books) or through the satellite network (transmission of films, still-frame video photographs, facsimile copies, etc.).

II. VIDEO

The most common television distribution system is one-way broadcast, with the program originating at one point and distributed to receive-only terminals. The entire capacity of a single satellite transponder is generally required to pass one television signal (compared to several hundred voice channels that could be handled by only one transponder).

Since commercial satellite charges are based on the amount of satellite capacity used, the cost of television delivery per channel is much greater than the cost of audio delivery. The cost of a full transponder, 24-hour per day use, has been estimated to be anywhere between $500,000 and $1 million per year.

Two-way television systems have been developed for special applications and experiments, but are not yet common. Simultaneous two-way television would cost approximately twice as much as one-way, since the use of two satellite transponders would be required.

The small earth stations currently being installed in Alaska will not initially have video capability, although they could be upgraded to receive television in the not-too-distant future.

One-Way Video

The simplest form of one-way video transmission is slow-scan still-frame. This would provide a still picture on a classroom TV set: either photographs, artwork, charts, slides, etc.

Use of this form of videc alone could prove helpful in providing resource materials. With slow-scan equipment at a central resource center, schools could make requests for material by telephone, or by satellite audio circuits, or directly through computer terminals in their schools. The center would then broadcast the still-frame material directly to the requesting school.

The advantage of this type of system is that it does not require the full bandwidth a standard video transmission needs, and channel costs would thus be cheaper.

III. VIDEO/AUDIO

Standard one-way video transmissions would almost always include one-way audio as well. There are very few conceivable applications for one-way video alone.

The most obvious application of one-way video plus audio is in the area of classroom instruction.

Instructional programs could cover the full range of rural curriculum, supplementing or offering specialized courses at virtually every grade level. Teacher training could also be provided by video programming. Programs could range from whole series, to special events, news, etc.

The equipment required in the classroom would be a standard video monitor (television set) with an on-off switch.

Programming sources could be a wide variety of national distributors of educational films or videotapes. DOE could also produce its own Alaskan-oriented instruction. A full color television production studio would cost a minimum of $75,000 to allow for basic program development. This cost would not include personnel necessary for program scripting, research, studio operation, on-camera talent, and a possible statewide coordination of rural educators to advise on program development.

Costs of television production can range from the high of the $80,000 per ½ hour average for commercial programming, to the $150 per ½ hour average for standard instructional programming. Obviously, the quality of the programming is at least somewhat dependent on the production budget.

It is also possible with a video system to record programs for later use or repetition. With addition of a VTR (video tape recorder), programs transmitted during evening hours could be automatically recorded on video cassettes, then replayed by teachers or students. A program on cassette could be kept for future use, or could be recorded over the following evening to provide a different program the next day. This would provide fairly passive instruction, requiring no direct student feedback unless initiated by the classroom teacher. Textbooks and/or teacher manuals could be provided to maximize system use.

Color TV monitors would cost about $500. VTR's cost about $1500, and a one-hour blank video cassette tape costs $25. The added advantage to this system is that this equipment is already available in many rural schools, and teachers are familiar and comfortable with its use.

One-way video and audio programs could also be interconnected with existing cable and television broadcast facilities in villages, to provide educational programming, PSA's and DOE information directly to the public.

A one-way video system might also be established with two-way audio capacity, allowing vocal interaction between students and video instructors. This would require placement of a microphone in the classroom, which would have an on-off switch.

Interactive audio would require a separate audio channel through the satellite, and the cost in addition to equipment would total the cost of one transponder and one additional audio channel.

This type of system has been conducted on an experimental basis in Alaska, over the ATS-6 satellite. From October 1974 through May 1975, elementary level programs in health education and basic oral language development were broadcast to 18 rural villages on a weekly basis. The programs used puppets and on-camera actors to teach basic principles. A ten minute period at the end of each program was used to allow students to interact with a live on-camera teacher.

Response to this educational experiment would indicate that most students were enthusiastic about the programs. Teaching manuals were distributed, although not all teachers used them consistently. Preliminary evaluation has indicated that it is vital to involve rural teachers in planning programs for their classrooms; that most teachers would have welcomed VTR equipment to enable them to record programs and use when most convenient; some students were intimidated by even the simplified microphone equipment in the classroom; interaction increased as students became more familiar with both the programs and the equipment. (More information on satellite experiments in Alaska is available from the Office of Telecommunications.)

Two-Way Video

Two-way video, with two-way audio, is in an experimental stage, but is another technical possibility. Two-way video would require essentially double the one-way amount of equipment needed at each broadcasting location. Equipment needed would include at least one color television camera, television monitor, and double the number of satellite channels required for one-way video.

A two-way video system could be either simplex or duplex.

During the ATS-6 experiment in Alaska, the Indian Health Service conducted an experiment in two-way television communication between a hospital and patients in outlying clinics. This was a simplex system: all stations operated on the same channel and only one station could transmit at any one time. Simultaneous two-way interaction was not possible.

During the same ATS-6 period, the University of Washington and the University of Alaska cooperated in a duplex television interchange. A group of medical students at U of A were able to view their instructor at U of W, while he was viewing the class and could respond to students individually, noting raised hands, etc. This experiment apparently worked out well, although it required two full satellite transponders instead of the one required for one-way or simplex operation.

Two-way video could also have application to teleconferencing for management or teacher support.

Teleconferencing systems are normally duplex, allowing simultaneous transmit and receive.

The simplest system for teleconferencing would be between two transmitting locations. Participants at both ends could see and hear each other, providing in essence a face-to-face discussion.

It would also be technically possible to expand this basic teleconferencing capability to include facsimile transfer and multiple screen monitors for showing graphs or charts in addition to conference participants.

It is unlikely that the small earth stations being installed in Alaska could be used for television transmission. But this teleconferencing principle might be useful to DOE on a more limited basis.

For example, facilities for teleconferencing could be established in Juneau, Fairbanks and Anchorage. A conference could be conducted between rural educators gathered in Fairbanks and DOE staff gathered in Juneau, eliminating the need for staff to travel to Fairbanks.

Video teleconferencing is a technical possibility, but it is expensive, since it uses two full satellite transponders. A full cost study might prove that sufficient savings in travel and time would justify the expense But it is also likely that an audio teleconferencing system could provide quite adequate interaction capabilities between rural educators and DOE.

SUMMARY

These are the basic telecommunications alternatives for Alaska. Some of them are immediately applicable, some will require future development and expansion of the initial earth station network.

Table 1 gives a summary of system requirements. Table 2 provides a summary of the alternatives immediately possible, and those that will be possible only at a future date.

System designs are best suited to specific applications, and those specifics must come from DOE. A good working premise is that there is practically nothing that can be thought of that can't be done by some medium or combination of mediums.

TABLE 1. SUMMARY OF SYSTEM REQUIREMENTS

		REQUIRED SATELLITE CAPACITY	PROGRAM SOURCE	EQUIPMENT		OPERATOR TRAINING		SUPPORT STAFF		SYSTEMS STABILITY	EQUIPMENT PLACEMENT	FLEXIBILITY OF USE
				TRANSMIT	RECEIVE	TRANSMIT	RECEIVE	TRANSMIT	RECEIVE			
ONE-WAY TRANSMISSION	AUDIO	1 or more audio channels	purchased programs or original productions ($10,000 audio studio minimum)	transmit studio ($500 up) B	$500/site or less B	audio broadcast or production training	minimal	one equipment operator/ broadcaster or audio production staff	one or more	minimal maintenance probable/ mechanical repair	transmit center/ field admin. offices/ classrooms	direct or recorded
	TELETYPE	less than 1 audio channel	written message	$1500 B	$1500 B	operate teletype keyboard	minimal	teletype operator	one or more	standard maintenance probable	transmit center/ field admin.	direct
	VIDEO (still frame)	less than 1 video channel	resource material/ library A	transmit studio C	$5000/site or less C	technical broadcast training	minimal	television production personnel	one or more	standard maintenance probable	transmit center/ field admin. offices/ classrooms	direct or recorded
	VIDEO + AUDIO	1 video channel + 1 audio channel	Purchased programs or original productions ($75,000 TV studio minimum A	transmit studio B	$500/site or less B	television broadcast/ production training	minimal	television production personnel	one or more	standard maintenance probable	transmit center/ classrooms	direct or recorded
TWO-WAY TRANSMISSION	AUDIO	1 or more audio channels	purchased programs or original productions ($10,000 audio studio minimum)	transmit studio ($500 up) B	$500/site or less B	audio broadcast or production training	minimal	equipment operators/ broadcasters or audio production staff	one or more	minimal maintenance probable/ mechanical repair	transmit center/ regional trans. centers/ field admin. offices/ classrooms	direct or recorded
	TELETYPE	less than 1 audio channel	written messages	$1500 B	$1500 B	operate teletype keyboard	operate teletype keyboard	teletype operator	one or more	standard maintenance probable	transmit center/ field admin. offices	direct
	FACSIMILE	1 telephone channel	written documents	$1300 B	$1300 B	operate facsimile copier	minimal	facsimile copier operator	one or more	minimal maintenance probable	transmit center/ field admin. offices/ classrooms	direct or recorded
	DATA TRANSFER (computer based)	more than 1 audio channel	purchased or original data program A	main computer or regional mini-computer C	computer terminals C	data processing	data processing	data processing personnel	one or more with training	frequent maintenance probable/ electro-mechanical repair	transmit center/ regional centers/ field admin. offices/ classrooms	direct or recorded
	VIDEO (1-way) + AUDIO	1 video channel + 1 audio channel	purchased programs or original productions ($75,000 TV studio minimum) A	transmit studio B	$2000/site minimum B	television broadcast/ production training	minimal	television production personnel	one or more	standard maintenance probable	transmit center/ classrooms	direct or recorded
	VIDEO + AUDIO	more than 1 audio + more than 1 video channel	live broadcasts A	transmit & receive studio B	transmit & receive studio	television broadcast/ production training	television broadcast/ production training	television production personnel	television production personnel	standard maintenance probable	transmit centers	direct

A - requires earth station upgrade
B - requires standard, readily available equipment
C - requires specially modified equipment

TABLE 2. SUMMARY OF IMPLEMENTATION POSSIBILITIES

	IMPLEMENTATION POSSIBLE AS EARTH STATIONS BECOME OPERATIONAL	IMPLEMENTATION POSSIBLE ONLY AFTER FURTHER DEVELOPMENT OF EARTH STATIONS OR EQUIPMENT
ONE-WAY TRANSMISSION		
AUDIO	X	
TELETYPE	X	
VIDEO (still frame)		X
VIDEO + AUDIO		X
TWO-WAY TRANSMISSION		
AUDIO	X	
TELETYPE	X	
FACSIMILE	X	
DATA TRANSFER		X
VIDEO (1-way) + AUDIO		X
VIDEO + AUDIO		X

SIMPLIFIED GLOSSARY OF COMMON TELECOMMUNICATIONS TERMS

ANTENNA. A device for picking up or radiating radio waves.

AUDIO. Frequencies in the audible range or information destined for the human ear.

BANDWIDTH. The frequency range of a signal or channel.

BIT RATE. The speed at which data bits are transmitted or received; usually expressed in bits per second.

CHANNEL. A subportion of the radio frequency spectrum, through which a particular type of information, (audio, data, video) is passed.

CHANNEL CAPACITY. The amount of information a channel can pass per unit of time.

COMMUNICATIONS SATELLITES. Satellites whose primary purpose is communications.

DATA. Information coded in the form of symbols or numbers.

DUPLEX. A two-way communications system in which communications take place between two points using separate transmit and receive channels. In such a system information can be transmitted in two directions simultaneously.

EARTH STATION. A terminal on the ground that receives and/or transmits information via satellite.

FACSIMILE. A system of transmitting documents of graphic material so that the received copy is a reproduction of the original.

FREQUENCY. For a periodically changing electrical wave or voltage, the number of cycles per unit of time usually expressed in cycles-per-second (Hertz).

MULTIPLEXING. Combining more than one type of signal for transmitting over a single channel.

ORBIT PATH. The path used by an orbiting satellite.

SIMPLEX. A two-way communications system in which two or more stations use the same communications channel so that only one station can transmit at any one time.

SYNCHRONOUS EQUATORIAL ORBIT. An orbital path approximately 23,300 miles above the earth's equator. A satellite placed in this orbital path revolves around the earth once every 24 hours, always remaining over a fixed point on the earth.

TELETYPE. A system of communicating alpha-numeric information in which the information is entered at the originating terminal by means of a typewriter-type keyboard, and printed out at the receiving terminal (s).

TRANSPONDER. Signal repeater in satellite.

VIDEO. The information contained in a television signal.

BIBLIOGRAPHY

Alpert, D. and Bitzer, D. L. "Advances in Computer Based Education." *Science*, March 20, 1970

Anatasio, Ernest J. and Morgan, Judith S. *Factors Inhibiting The Use Of Computers In Instruction.* A final report to the National Science Foundation. Princeton, New Jersey: EDUCOM Inter-university Communications Council, Dec. 1972.

Darby, Jr. Charles A. *The Computer In Secondary Schools.* New York: Braeger Publishers, 1972 (LB, 1028.5, D 3).

Doty, Pamela "Public Access Cable TV: Who Cares?" *Journal of Communication*, Summer 1975.

Dunkleberger, Gary E. and Smith, Ruth W. "An Approach To Computer Managed Instruction." *Audiovisual Instruction*, November 1975.

Demearth, Nicholas J. and Daniels, Lois A. *How To Make "The Fourth Revolution" Human Factors In The Adoption Of Electronic Instructional Aids.* A paper presented to the National Aeronautics and Space Administration, Center for Developmental Technology, Washington University, St. Louis, Missouri, December 1973.

Dunn, Alex and Morgan, Catherine E. "Individualization - A Reality With Computer Support" *Audiovisual Instruction*, May 1974.

Eldridge, Frank R. *Telecommunications Systems For Social And Rehabilitation Services*, The Mitre Corporation, M 72-202, December 1972.

Etzioni, Amitai; Laudon, Kenneth; Lipson, Sara "Participatory Technology: The MINERVA Communications Tree" *Journal of Communication*, Spring 1975.

Galloway, Jonathan F. *The Politics and Technology of Satellite Communications*, Lexington, Mass. (D.C. Heath & Co.) 1972

Gardiner, E. M. *Telecommunications User Alternatives Study*, a report presented to the State of Alaska, Office of Telecommunications by the Boeing Aerospace Company, August 31, 1974.

Kohn, Bernice *Communications Satellites: Message Centers In Space*, New York Four Winds Press, A Division of Scholastic Magazines, Inc. 1975.

Lee, H. Rex "As I See It" A paper presented to the Convention of Western Radio and Television Association and West Coast Instructional Television. Seattle, Washington, February 25, 1969.

Levien, Roger E. *The Emerging Technology*, New York: McGraw-Hill Book Co. 1972 (LB, 1028.5, L 49)

Lewis, Phillip "Instructional Technology: Revolution On The Horizon," *Nations Schools,* December 1968.

Lipman, Dale *Technology In The Public Schools?* A report prepared for the National Science Foundation. Report number 73/6. St. Louis, Missouri: Center for Developmental Technology, Washington University, December 1973.

Mathison, Stuart L. *Computers and Telecommunications: Issues In Public Policy,* Englewood Cliffs, New Jersey: Prentice Hall, Inc. 1970.

Morgan, Robert P. and DuMolin, James R. *An Instructional Satellite System For The United States: Preliminary Considerations.* A report prepared for the National Aeronautics and Space Administration, Internal Memorandum no. 71-2, Program on Application of Communications Satellites to Educational Development, Washington University, St. Louis, Missouri, July 16, 1971.

Morgan, Robert P.; Singh, Jai P.; Robinson, Burke E. *Technology In The Future Of Education, Research* for Better Schools, Inc. Philadelphia, Pennsylvania, August 1973.

Morgan, Robert P.; Singh, Jai P.; Rothenburg, Donna; Robinson, Burke E. *Large-Scale Educational Telecommunications Systems For The U.S.: An Analysis Of Educational Needs and Technological Opportunities.* A report prepared for the National Aeronautics and Space Administration, and the National Science Foundation, Internal Memorandum no. 75-1, Center for Development Technology, Washington University, St. Louis, Missouri, April 1975.

Morley, Jr. Robert E. and Eastwood, Jr. Lester F. *Alternative Communication Network Designs For An Operational Plato IV CAI System.* A report prepared for the National Science Foundation. CDTCG-R(T) - 73/3. Center for Development Technology, Washington University, St. Louis, Missouri, August 1975.

Parker, Edwin B. *Social Implications Of Computer/Telecommunications Systems* A report prepared for the National Science Foundation. Report no. 16 Center for Interdisciplinary Research, Stanford University, Stanford, California. February 1975.

Polcyn, Kenneth A. *An Educator's Guide To Communications Satellite Technology,* a resource facility for developing country educators interested in the uses of technology for education. Information Center on Instructional Technology, September 1973.

Sheridan, Thomas B. *"Community Dialogue Technology", Proceedings Of The IEEE,* Volume 63, No. 3, March 1975.

Stetten, Kenneth J. *Toward A Market Success For CAI:* An Overview of the TICCIT Program, the Mitre Corporation, M 72-73, June 1972.

Tennyson, Robert D. *Applications Of Computers In Education.* A paper presented at the annual convention of the Federation of American Societies in Experimental Biology in Atlantic

City, New Jersey, 1973.

---------- *An Educational Requirement and Technology Survey.* A paper presented to the Alaska Educational Broadcasting Commission and the Educational Telecommunications Consortium. Prepared by Teleconsult, Inc. Washington, D. C., September 1971.

---------- *A Study Of The Potential Of Telecommunications and Educational Technology To Satisfy The Educational Communications Needs Of The State Of Alaska.* A paper presented to the State of Alaska by Teleconsult Incorporated, Washington, D. C., May 1972.

---------- *A Resource For The Active Community.* Developed by the Broadcast Programmes and Research Branches of the Canadian Radio/Television Commission, 1974.

---------- *The Fourth Revolution: Instructional Technology In Higher Education.* A report and recommendations by the Carnegie Commission on Higher Education, New York: McGraw-Hill Book Co., June 1972.

Filep, Robert T. Ph. D. *Communication Satellites and Social Services, Focus on Users and Evaluations, An Annotated Bibliography.* A joint activity of the Annenberg School of Communications and the Learning Systems Center of the University of Southern California, November 1975.